

Synergizing Data Analysis and Machine Learning with Simulation Data Management

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1 Summary

Employing a simulation data management system ensures a comprehensive archive of all conducted simulations within a specified timeframe. This encompasses crucial simulation metadata such as load cases, solver versions, and components, along with the simulation output comprising raw data and derived key-results. Centralizing and organizing this data in a uniform structure facilitates seamless data analysis and knowledge extraction across numerous simulations.

The utilization of open machine learning libraries and third-party solutions enhances the extraction of insights from the stored data, enabling the identification of patterns and trends essential for making data-driven decisions.

This presentation will illustrate the workflow for setting up simulation data and conducting simulations to generate key results necessary for data analysis. Additionally, it will showcase the integration of third-party solutions, such as Femalyst from SIDACT or our proprietary Data Analysis Add-On, through the scalable Add-on concept of SCALE.result.

By adopting this Add-On approach, SIDACT and other entities can seamlessly integrate their technology as third-party tools into existing simulation data management systems, leveraging proprietary front and back-end components while gaining access to simulation data.

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Agenda

Motivation

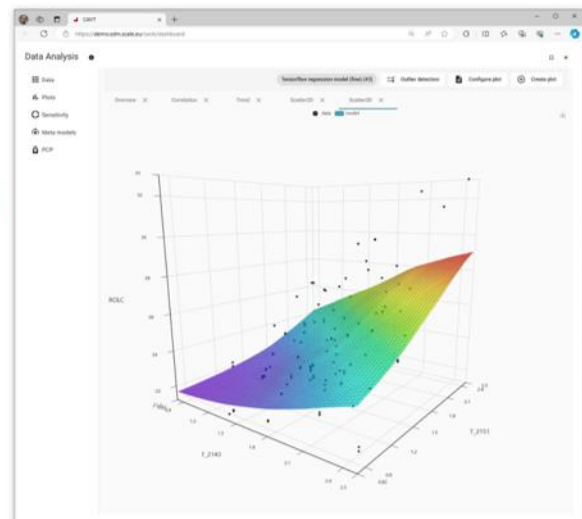
Automatization

Integration of 3rd party Data Analysis add-on in an SDM system

- Example of DOE study
- Example of Event Detection

Outlook

SCALE 

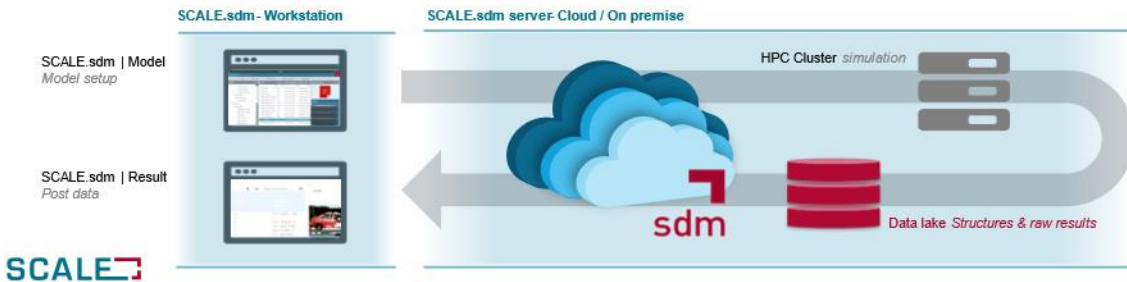


Motivation



Large data sets available in SDM systems

- Huge number of simulations every day
- Some OEMs with > 1.5 Million simulations per year
(just crash domain only)
- Data stored at central place



Motivation



Advanced ML/AI Methods:



- often custom / proprietary
- SDM provides standard methods
- Domain-specific methods required
(specific methodologies are often required but not part of standard software or implementations)
- ML/AI Methods custom developed
(in-house, proprietary or even open -source based)

Result

Key Features

The slide is divided into two main sections: 'Available' and 'In Development / Integration options'.

Available:

- Correlation:** Anihil plots
- Visualization:** Scatter plots w response surfaces
- Outlier Detection:** for scalars
- Sensitivity Analysis:** nonlinear Sobol indices
- Meta Modeling:** NN based / Polynomial

In Development / Integration options:

- Amazon Quicksight Amazon Sagemaker:** Serverless Analysis Solution <https://www.amazon.com/quicksight>
- Time Series Classification:** Labeling / Error Detection Q3/2021
- SIDACT/SCAI Event Detection:** Outlier Detection on Simulation / Part level
- Permissible Design Ranges:** Detects input ranges leading to permissible designs

Introduction of Company and Products 10

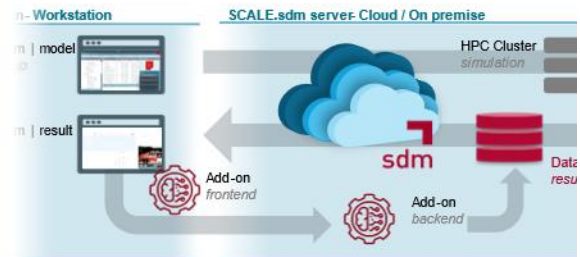


Problem

- Application of AI/ML methodologies implies scanning large data sets
- Implementation close to data required vs. custom implementation

Solution @ SCALE.sdm

- Add-on concept available
- Distribution of own code to **backend** and **frontend** side in SCALE.sdm possible
- Full structured access to data within server environment



SCALE

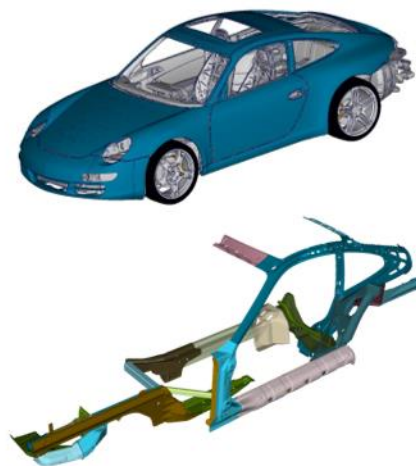
Setup of DOE - Porsche 911 Example

Loadcase USNCAP Rigid Wall

- Vehicle Speed 56 km/h
- 100% frontal

Design of experiments

- sheet metal thickness of **38** parts
[0.8, 2.5]; [1.5, 5.0] mm
- **60** simulation runs



SCALE

The model has been provided by Dr. Ing. h.c. F. Porsche AG which is gratefully acknowledged.

Setup of Simulation Model and DOE in SDM-System



Model

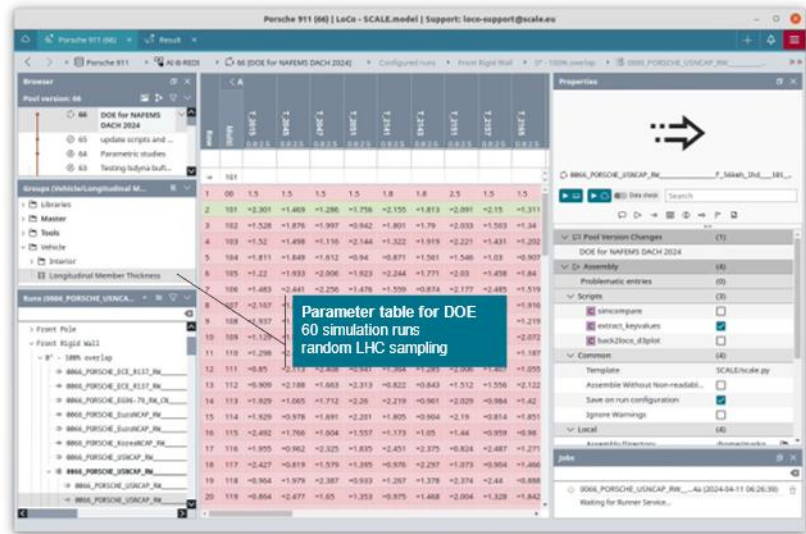
- Multiple load cases in SDM-System

Parameterization

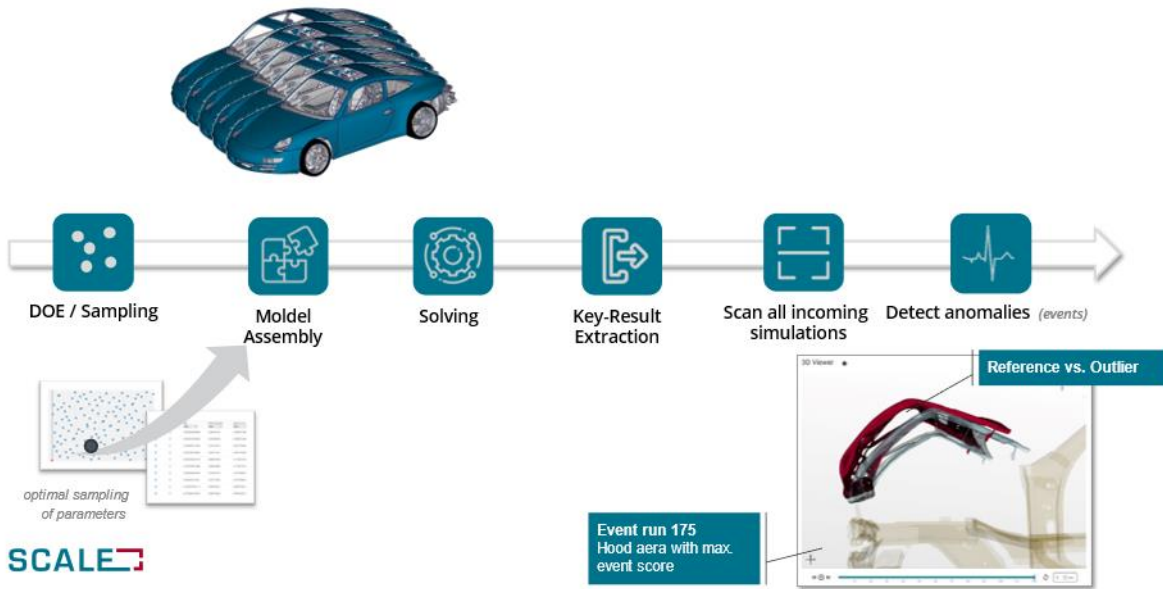
- LS-DYNA parameters
- Placeholder in .key files

DOE

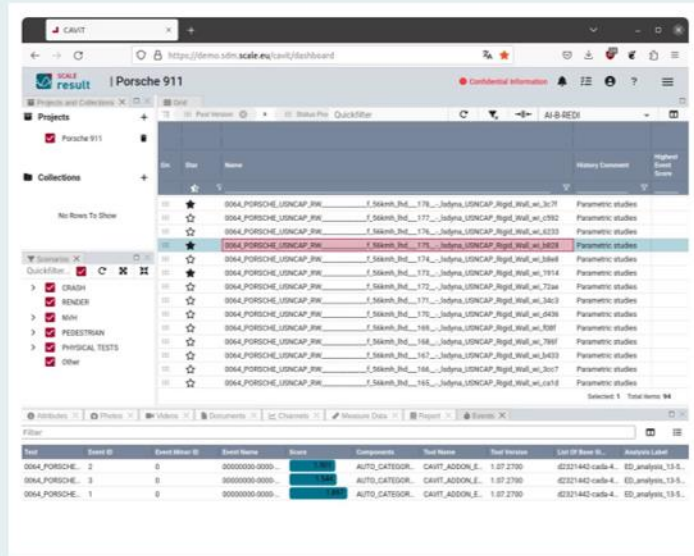
- Samplings can be created directly in SDM-System
- Simulation runs created automatically



Simulation flow in SDM-System for DOE and event detection



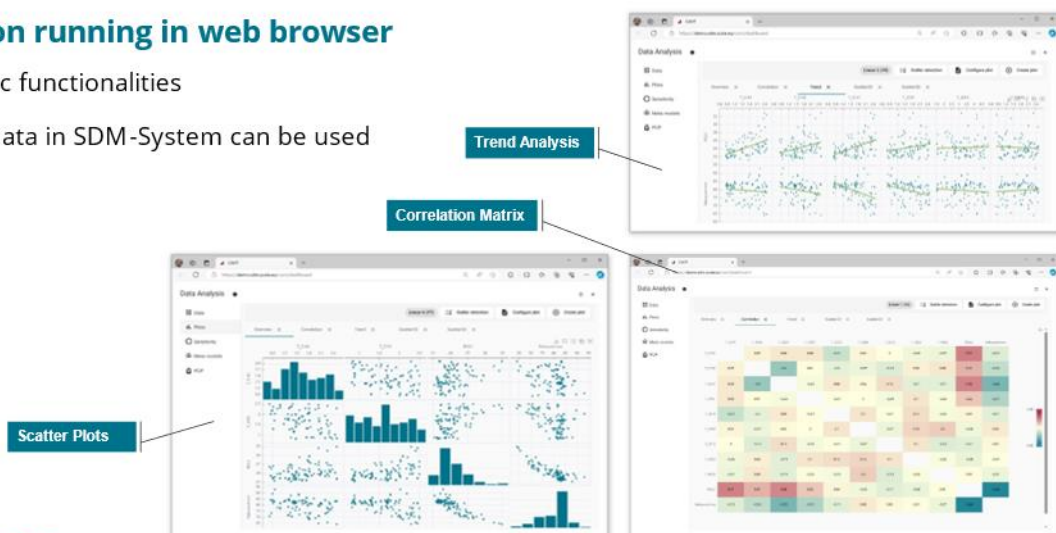
-  **CAT & CAE**
Compare simulation and physical tests
-  **Evaluation**
Visualize and evaluate all key results
-  **Assess Results**
Assess with respect to project targets
-  **Reporting**
Comprehensive and interactive reports
-  **Data Analysis**
Machine Learning and Data Mining

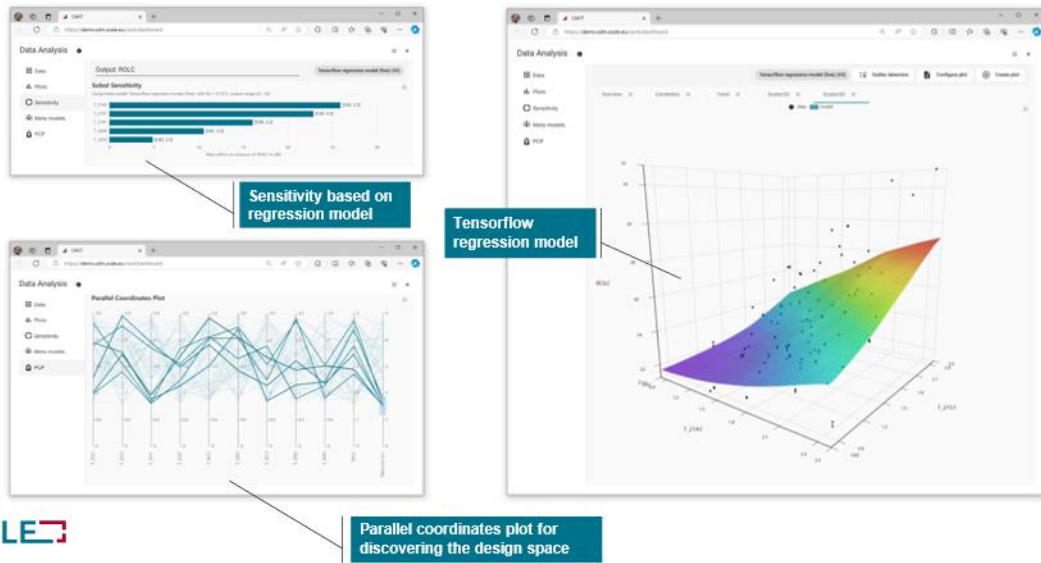


Example SCALE Data Analysis Add-on

Add-on running in web browser

- Basic functionalities
- All data in SDM-System can be used





SCALE

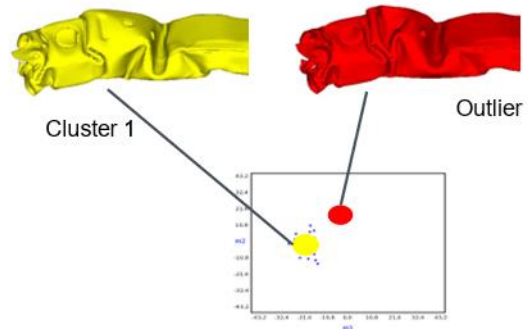
What is an event?

- Unknown/unwanted behavior
- anomalies in field variables



Event properties

- Location/Parts
- Outlier Score
- Event type



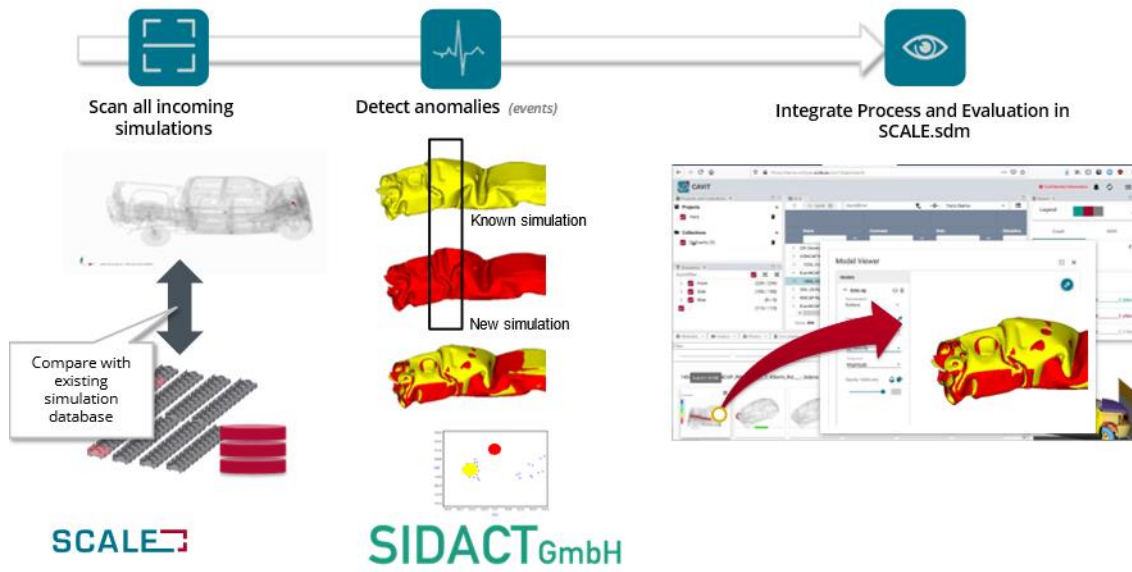
Basic workflow



SCALE

SIDACT GmbH

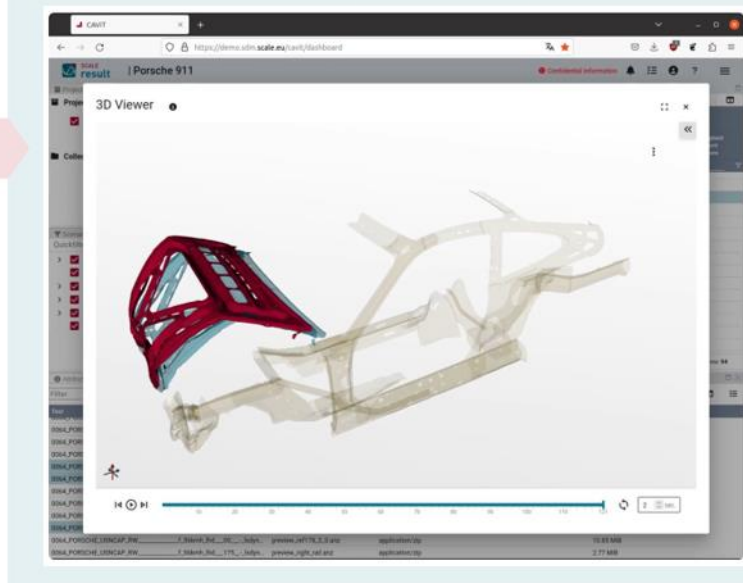
Example SIDACT Event Detection: ML based anomalie detection

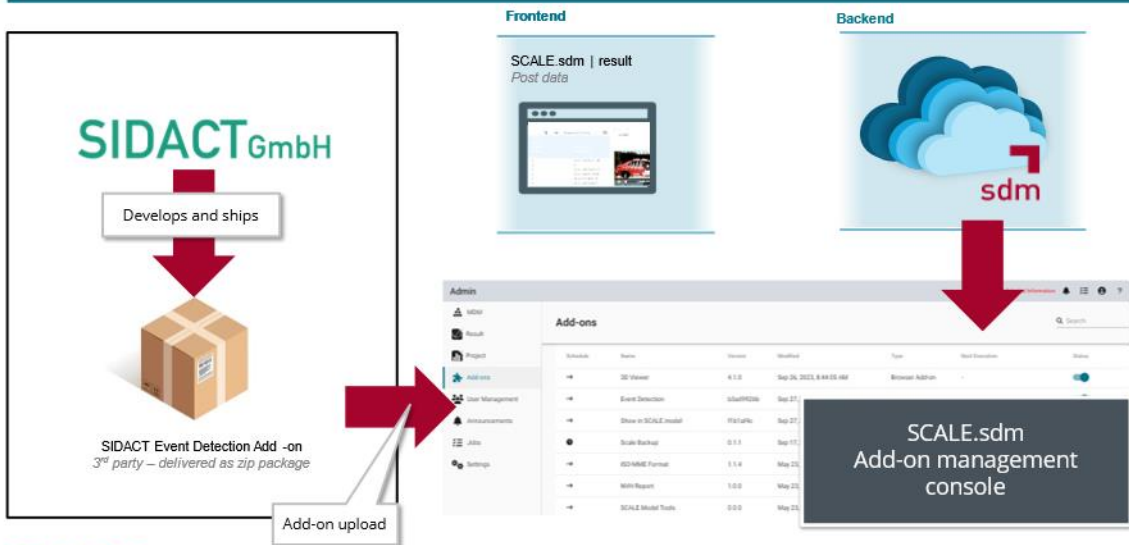


Visualization in Result

Porsche 911 Example

-  **CAT & CAE**
Compare simulation and physical tests
-  **Evaluation**
Visualize and evaluate all key results
-  **Assess Results**
Assess with respect to project targets
-  **Reporting**
Comprehensive and interactive reports
-  **Data Analysis**
Machine Learning and Data Mining





Summary

- SDM systems provide structured data sets
- Application of AI/ML methodologies implies scanning large data sets
- Often domain-specific custom ML methods
(specific methodologies are often required but not part of standard software or implementations)
- Add-on concept enables custom ML-methods and UI extensions in SDM systems
- Example Application: Event Detection by SIDACT

